DEQ Montana Department of Environmental Quality

Statement of Basis

MONTANA HAZARDOUS WASTE PERMIT MODIFICATION
For Remedy Selection

Phillips 66 Company Billings Refinery401 South 23rd Street
Billings, Montana

Final Determination for Remedy Selection

Selected Remedy
The Department of Environmental Quality (DEQ) has made a final determination on remedy selection for the Phillips 66 Company Billings Refinery. DEQ has selected the proposed remedy described in the Statement of Basis.

Public Participation
The public was given the opportunity to comment on DEQ's proposed remedy selection, as described in the Statement of Basis. DEQ received general comments on the proposed remedy and permit modification. DEQ has completed a Response to Comments in accordance with 40 Code of Federal Regulations (CFR) 124.17 (incorporated by reference in Administrative Rules of Montana (ARM) 17.53.1201).

The final decision is dated September 30, 2022. An appeal of DEQ's decision must be submitted to the Montana Board of Environmental Review by October 31, 2022 (75-10-406(4), Montana Code Annotated). The final permit decision shall become effective on November 1, 2022, unless appealed.

Executive Summary

Phillips 66 Company Billings Refinery operates a petroleum refinery on the southeast side of Billings, Montana. The refinery occupies about 200 acres.

Phillips 66 Company Billings Refinery is required by the Montana Hazardous Waste Act to have a Montana Hazardous Waste Permit for cleanup of contaminated soil and groundwater at the refinery. The process of investigation and cleanup of contaminated media is called corrective action.

Historical activities resulted in release to soil and groundwater of hazardous waste and materials that contained hazardous constituents. The main hazardous constituents of concern in groundwater and soil at the refinery are benzene, toluene, ethylbenzene, xylenes, and vinyl chloride. Cleanup work has been occurring at the refinery since the 1990s.

In 2002, the Montana Department of Environmental Quality (DEQ) approved a site-wide soil and groundwater cleanup remedy for the refinery when a Montana Hazardous Waste Permit was issued. DEQ is proposing to modify the permit to include additional remedy requirements. The proposed remedy includes corrective action for areas of the refinery that were not included in 2002 and to change the remedy for site-wide groundwater boundary control from the current groundwater pump and treat system to sparging technologies.

This Statement of Basis summarizes the proposed remedy submitted by Phillips 66 Company in *2021 Outstanding SWMU/AOC Corrective Measures Study Report* dated November 8, 2021. The remedy includes all known contaminated areas of the refinery.

The proposed remedy includes:

- Cleanup measures for contaminated areas of the refinery known as the South 40 DNAPL Area, Butane Release Area, Glacier Manifold Pipeline Release, and Jupiter Sulfur Expansion. These areas were not included in the 2002 approved remedy.

- Changing the groundwater boundary control from a groundwater pump and treat system to sparging technologies.

- Source and boundary control measures for hydrocarbon and vinyl chloride groundwater plumes.

DEQ proposes approval of this remedy because the addition of this remedy to on-going corrective action will continue the protection of human health and the environment.

List of Acronyms

AOC	Area of Contamination
BTEX	Benzene, toluene, ethylbenzene, and xylenes
COI	Constituents of interest
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CVOCs	Chlorinated volatile organic compounds
DEQ	Montana Department of Environmental Quality
DNAPL	Dense non-aqueous phase liquid
EFL	East Fence Line
GWIS	Groundwater interceptor system
IM	Interim Measures
LNAPL	Light non-aqueous phase liquid
MNA	Monitored natural attenuation
NAPL	Non-aqueous phase liquid
NFL	North Fence Line
NSZD	Natural Source Zone Depletion
O-P	Oxygen-Peroxide
Phillips 66	Phillips 66 Company Billings Refinery
ROI	Radius of Influence
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
VC	Vinyl Chloride

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1. Introduction

1.1 Facility Description

Phillips 66 Company Billings Refinery (Phillips 66) is an operating petroleum refinery that began operation in 1949. The refinery converts crude oil and field butane into liquefied petroleum gases, gasoline, jet fuel, diesel fuel, fuel oils, and petroleum coke. The refinery is located on the southeast side of Billings, Montana and covers about 200 acres. See Figure 1. Site Location.

1.2 Site Geology and Hydrology

The refinery is situated on an alluvial terrace deposit associated with the Yellowstone River. The river is approximately 1,000 feet east of the refinery. The geology underlying the site is clay-silts from ground surface to about 6 feet below ground surface, sandy-gravels from 6 to 22 feet below ground surface, and gray shale bedrock (Colorado Shale) at approximately 22 feet below ground surface. The bedrock contact at the refinery varies between 17 to 25 feet below ground surface.

The Colorado Shale acts as an aquitard. An aquitard limits the downward flow of water. Groundwater flows northeast towards the Yellowstone River.

1.3 Regulatory Authority

Phillips 66 was issued a Montana Hazardous Waste Permit #MTHWP-18-01 on September 21, 2018. The permit requires Phillips 66 conduct corrective actions to cleanup releases of hazardous waste and hazardous constituents in soil and groundwater that are a result of past refinery activities. The 2018 permit was a renewal of a hazardous waste permit originally issued in 2002. A permit modification in 2006 for the South Oily Sludge Pits (SOSP), the regulated unit at the refinery, changed the approved remedy for the SOSP. In 2009 DEQ approved the Corrective Measures Implementation Certificate Report and Certification of completion for the SOSP.

1.4 Purpose of Permit Modification

In 2002, DEQ approved a site-wide soil and groundwater cleanup remedy for the refinery and incorporated the remedy into the hazardous waste permit. A permit modification is necessary for DEQ to select a remedy for certain areas of the refinery that were not included in the 2002 remedy. Areas of contamination at the refinery are called Solid Waste Management Units (SWMUs) and Areas of Concern (AOC). Table 1 list all the SWMUs and AOCs at the refinery and their corrective action status. Figure 2 shows their location at the refinery.

The modification is also needed for a proposed remedy change for the site-wide groundwater boundary control. The proposal changes the boundary control remedy from the groundwater interceptor system (GWIS) to sparging technologies. Phillips 66 proposed the change in the *2021 Outstanding SWMU/AOC Corrective Measures Study Report* dated November 8, 2021. Table 2 summarizes all the refinery SWMUs and AOCs, 2021 Corrective Measures Study evaluation results, and proposed actions.

2. Proposed Remedy

The Phillips 66 proposed remedy is grouped as exposure controls, boundary controls, and source controls.

2.1 Exposure Controls

Exposure control methods and technologies are intended to prevent unacceptable exposure to human health and the environment by managing potential exposure pathways. Exposure control technologies include engineering controls, institutional controls, and management plans. The proposed exposure controls will:

- Maintain environmental staff for project management and coordination.
- Maintain engineering controls to control exposure from contaminants and protect human health (i.e., fencing, security, soil cover, personal protective equipment).
- Maintain management plans (i.e., prohibit underground storage tanks, conduct above ground storage tank inspections, utilize pipeline and sewer inspections, conduct turnarounds, continue soil/waste management programs).
- Continue employee specific training programs, including but not limited to: Refinery Annual Site-specific Trainings, Hazardous Waste Operations Training, Emergency Response and Pollution Prevention Training.
- Continue to implement institutional controls that address potential exposure pathways related to contaminated groundwater and soil as well as restrict future land use to industrial use.

2.2 Boundary Controls

Boundary control technologies prevent migration of constituents of interest (COIs) off refinery property. These controls may not have a significant effect on concentrations of COIs in source areas. As part of the boundary control portion of the remedy, Phillips 66 will:

- Discontinue the use of the groundwater interceptor system (GWIS) for hydraulic control. GWIS wells and associated piping and appurtenances may be completely decommissioned, abandoned, and removed by Phillips 66.

- Operate sparging systems along the Refinery's eastern and northern boundaries: the East Fence Line (EFL) Biosparge, North Fence Line (NFL) Biosparge, and EFL Oxygen-Peroxide (O-P) Sparge Systems. The Southeast Ozone-Peroxide Sparge System will be installed in 2022. Existing air sparging systems may be modified and new systems added as needed to maintain boundary control and target specific COIs.

- Continue to monitor the effectiveness of in-situ bioremediation of groundwater.

- Continue to conduct groundwater monitoring including compliance monitoring, performance monitoring, and plume monitoring.

2.3 Source Controls

Source controls are intended to reduce or eliminate the source of COI to prevent migration. Under the source control portion of the remedy, Phillips 66 will:

- Continue operation of the 2nd Street Biosparge System to reduce COI mass in the aquifer affected by the reformate release near Tank 21.

- Continue product removal activities at any well containing measurable non-aqueous phase liquid (NAPL). Wells will be added or removed from the recovery list based on ongoing product recovery data. Removal methods may vary as conditions warrant.

- Continue to investigate and repair oily water process sewers.

- Continue to optimize remedial efficiencies by using supplemental technologies to reduce source mass in the Reformate Release Area, South 40 Dense Nonaqueous Phase Liquid (DNAPL) Area, areas of the south-central portions of the refinery, and the vinyl chloride plume. Need for supplemental technologies will be based on the success of approved source and boundary control technologies. Supplemental remedial technologies may include, but are not limited to, excavation, air sparging and soil vapor extraction, amendment injections, and thermal conductive heating.

Table 2 summarizes the proposed remedial actions. The table includes all SWMUs/AOCs and notes SWMUs/AOCs impacted by the change from GWIS to sparging technologies.

3. Corrective Action History

3.1 Facility-Wide

Phillips 66 and EPA agreed to an Administrative Order on Consent in 1990. The Administrative Order required Phillips 66 to perform facility-wide corrective action. Corrective action is a cleanup process for investigating releases of contamination to the environment and designing remedies to address those releases. The Administrative Order also required Phillips 66 to install interim corrective measures to address contamination that presented an immediate or potential threat to human health or the environment.

In 1993, the GWIS was installed as an interim measure to control the off-site migration of contamination in groundwater. Originally it functioned as dual-phase pump and treat system for the recovery of free-phase petroleum products (including light nonaqueous-phase liquid [LNAPL]) and hydrocarbon-impacted groundwater. The GWIS's groundwater recovery wells extended along the northern and eastern refinery boundaries. The recovered water and LNAPL was treated in the refinery's wastewater treatment system.

In 1997, EPA approved the RCRA facility investigation report (RFI) and risk assessment. The report presented the results of an investigation to determine the nature and extent of groundwater, surface water, and soil contamination on and off-site. The objective of the risk assessment was to identify potential human health and ecological risks.

The RFI determined the constituents of interest (COI) in groundwater include benzene, toluene, ethylbenzene, and xylenes (BTEX), chlorinated volatile organic compounds (CVOCs), phenolics, polycyclic aromatic hydrocarbons (PAH), and arsenic. Surface and/or subsurface soil COIs include BTEX, CVOCs, PAHs, and metals. Some of the soil had the potential to leach COIs from soil to groundwater.

As a result of the RFI findings, EPA required Phillips 66 to conduct a Corrective Measures Study (CMS). The CMS addressed specific areas of contamination at the refinery and site-wide groundwater. A remedy was selected for these areas in 2002. See Table 1 for the areas included in the 2002 approved remedy.

With the completion of the CMS the requirements of EPA's Administrative Order were fulfilled. The Administrative Order was terminated, and a Montana Hazardous Waste Permit was issued in 2002. The permit incorporated the selected remedy and required implementation of the corrective measures. The permit was renewed in 2018.

Phillips 66 submitted a Corrective Measures Implementation Plan (CMI) to implement the remedy. The CMI was approved by DEQ on March 9, 2005. The CMI included the plan to implement the approved remedy. An updated CMI was approved by DEQ on January 22, 2016. The latest CMI Work Plan approved was *Updated Phase 2 Corrective Measures Implementation*

Work Plan – Addendum 01: Site-Wide Groundwater Monitoring Work Plan; it was approved on April 25, 2018.

The permit also required investigation and remedy selection for SWMUs/AOCs that were not included in the 2002 remedy. The outstanding SWMUs/AOCs, known in 2002, included the South Oily Sludge Pits (SOSP) and South 40 DNAPL. Since the 2002 permit issuance, additional releases have occurred or been identified. These SWMUs/AOCs include the Butane Release Area, Glacier Manifold Pipeline Release, and Jupiter Sulfur Expansion.

Phillips 66 submitted a CMS for the South Oily Sludge Pit (SOSP) on October 14, 2005. A permit modification incorporating the remedy for the SOSP was finalized on March 30, 2006. On October 2, 2009, DEQ approved the Corrective Measures Implementation Certification Report and Certification of Completion for the SOSP. No further corrective action is required for vadose zone soils at the SOSP, unless future data indicates a release.

3.2 Interim Measures, GWIS Shutdown Testing, and Other Remedial Activities

In 2005 DEQ allowed Phillips 66 to shut down a portion of the GWIS because of the absence of LNAPL and decreasing dissolved phase hydrocarbon contamination in groundwater. The shutdown was necessary to determine if monitored natural attenuation was sufficient to ensure compliance with remedy objectives.

New spills and releases, including the reformate release which occurred within the existing Tank Farm AOC, caused an increase in LNAPL and dissolved phase contamination that exceeded the capacity of monitored natural attenuation. The GWIS was returned to service for boundary control to mitigate off-site migration of COIs.

In 2015, DEQ approved the 2nd Street Biosparge System as an interim measure. Phillips 66 proposed the corrective action to address groundwater impacts in the northern portion of the refinery and enhance the operation of the GWIS. Biosparging was not included in the 2002 selected remedy for the site. However, based on the pilot study conducted in this area, DEQ agreed that biosparging should reduce the level of COIs in the groundwater.

Phillips 66 proposed biosparging along the east side of the refinery as an interim measure to address contaminated groundwater and enhance the operation of the GWIS. The sparge system addressed COIs in groundwater from the Butane Release Area. The *East Fence Line Biosparging System Work Plan* was approved by DEQ on September 7, 2016.

In 2017, DEQ approved Phillips 66's request to shutdown extraction wells located in the northern half of the refinery. A sparging system for the northern portion of the refinery was approved on May 11, 2018, after Phillips 66 submitted the *North Fence Line Sparge System Interim Measures Work Plan.* The system was constructed as a boundary control measure to prevent off-site migration of BTEX and to promote downgradient biodegradation of COIs.

To address concerns about off-site migration of COIs, including vinyl chloride at compliance point PZ-19, Phillips 66 proposed additional sparging along the east side of the refinery. The *East Fence Line Ozone-Peroxide Sparge System Work Plan* was approved on July 12, 2017. The East Fence Line Ozone-Peroxide (EFL O-P) Sparge system injects concentrated oxygen and/or ozone blended with ambient air. Hydrogen peroxide injection occurs when ambient temperatures are expected to be above the freezing point of the hydrogen peroxide solution. This interim measure was intended to address contaminated groundwater along the east side of the refinery and reduce or eliminate reliance on the GWIS.

Interim remedial sparging technologies were originally implemented to enhance biodegradation of COIs at the refinery and reduce or eliminate the need for the GWIS. All GWIS locations are currently part of a phased shutdown test. On July 6, 2018, DEQ approved the *East Fence Line Groundwater Interceptor System Shutdown Test Work Plan*. The *North Fence Line Groundwater Interceptor System Shutdown Test Work Plan* was approved on August 20, 2019.

Vinyl chloride contamination in groundwater monitoring continues to be a concern along the eastern side of the refinery. DEQ approved Phillips 66's *East Fence Line Ozone-Peroxide Sparging System Expansion Work Plan* on December 30, 2020. The goal of expanding the sparge system was to address the gap between the current boundary control remediation systems.

The phased GWIS shutdown allows evaluation of sparging systems. The status of the GWIS shutdown is as follows:

- GWIS wells in the North 40 (RW-112, RW-113, and RW-114) were shut off and removed from service in November 2018 and have remained inactive.

- In July 2018 work began on the EFL GWIS shutdown test. The purpose of the EFL GWIS shutdown test was to confirm the effectiveness of the EFL and EFL O-P interim measures sparge systems at maintaining compliance with the permit.

- In September 2019, the NFL GWIS shutdown test was initiated. The purpose of the test was to confirm the effectiveness of the 2nd Street and NFL interim measure sparge system at maintaining compliance with the permit.

The following sparging systems are currently operating (Figure 3. shows the location of the sparge systems):

- 2nd Street Biosparge System

- East Fence Line Biosparge System

- EFL Ozone-Peroxide Sparge System –The EFL O-P Sparge system operates as an ozone sparge system during colder weather. Hydrogen peroxide is added during warm weather.

- North Fence Line Sparge System

3.3 South 40 DNAPL Area

The South 40 DNAPL Area is in the south-central portion of the refinery and is adjacent to other SWMUs/AOCs. Initial investigation in this area was required in 1999 because dense non-aqueous phase liquid (DNAPL) was detected in three wells. Historical information shows that several waste impoundments are the source of DNAPL contamination. These impoundments were unlined pits that are believed to have stored hydrocarbon waste. The South 40 DNAPL Area is also part of the source causing vinyl chloride contamination of groundwater.

Investigation of soil and groundwater indicate that DNAPL is not migrating. The most impacted soil is generally located from 6 to 16 feet below ground surface. Sampling of similar material at the SOSP showed contamination of soil exceeding EPA's Soil Screening Levels for BTEX, CVOCs, and some metals.

Five remediation technologies for DNAPL and groundwater contamination at the South 40 DNAPL Area have been evaluated in bench scale testing, assessment, and/or pilot scale testing. The five technologies include chemical oxidation, source encapsulation, enhanced biotransformation, air sparge/soil vapor extraction, and ozone sparging.

3.4 Butane Release Area

The Butane Release Area is located to the east of the wastewater treatment area on the eastern edge of the refinery. The area is west of E Street near the secondary dissolved air floatation building.

The Butane Release Area was caused by a leak of field butane from a delivery pipe. The leak was identified in 2006. The leaking section of pipe was abandoned and replaced by a new aboveground pipe in 2006.

LNAPL is present in the area, but groundwater monitoring results show that COIs do not extend beyond the EFL Biosparge System.

3.5 Glacier Manifold Pipeline Release Area

The Glacier Manifold Pipeline Release Area refers to an area around the Glacier Pipeline crude oil manifold. A crude oil release was discovered in 2007 from the underground pressure relief line. The line was abandoned and replaced with an aboveground line. Phillips 66 installed wells

and culverts and began recovering LNAPL with a vacuum truck. Over 30,000 gallons of crude oil were recovered from the Glacier Manifold area between 2007 and February 2011. In 2011 operation of the automated LNAPL recovery system stopped but vacuum truck LNAPL recovery continued. Approximately 4000 gallons of crude oil has been recovered from the Glacier Manifold area since 2011.

A *Glacier Manifold Area Light Non-Aqueous Phase Liquid Management Work Plan* was completed in June 2021. The work plan evaluated natural source zone depletion (NSZD) with optimization of LNAPL recovery. Optimization is necessary to address residual LNAPL in groundwater and declining LNAPL recovery rates. The effectiveness of NSZD will be evaluated during groundwater monitoring events.

3.6 Jupiter Sulfur Expansion Area

In 2015, Phillips 66 identified a new SWMU in the vicinity of Jupiter Sulphur, LLC during construction activities related to the expansion of the Jupiter Sulphur plant. An RFI was conducted in 2017 to delineate the vertical and lateral extent and composition of contamination in the soil. The contamination is likely associated with past operations at the Area 3 Landfarm. Historical delineation of the extent of Area 3 Landfarm appears to have been incomplete.

Concentrations of several COI exceeded EPA soil screening levels in surface or subsurface soil for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). However, the 2017 RFI Report concluded that groundwater analytical results indicate the Jupiter Sulfur Expansion Area is not a significant source of COIs leaching from soil to groundwater. Phillips 66 proposed ongoing site-wide groundwater monitoring was sufficient to track groundwater impacts from this SWMU.

3.7 Reformate Release Area

Petroleum hydrocarbon-stained soil was discovered in 2012 near the east side of Tank 21 underneath a pipe rack. Soil samples from hand borings exceeded BTEX limits set in DEQ's Risk-Based Screening Levels (RBSLs). The source of the petroleum hydrocarbon contamination was determined to be a pinhole leak in a buried reformate transfer line located at the east-west road crossing to the southeast of Tank 21. The Reformate Release Area is within the Tank Farm AOC.

To remediate the surface soil (top 24 inches), a microbial amendment flooding technique combined with a time-release oxygen compound was used. This approach was used to accelerate biodegradation of the hydrocarbon mass in the surface soils. Soil tilling was incorporated both pre- and post-application. Confirmation soil samples were collected following the remedial activities that showed BTEX concentrations were below EPA regional screening levels for exposure of industrial workers.

Data from quarterly groundwater monitoring events indicate the Reformate Release Area is a source of BTEX to groundwater. A biosparge pilot test was installed downgradient from the reformate release. The biosparge pilot test ran from December 18, 2014 through April 2, 2015. Biosparging was found to be a useful remedial technology because it reduced BTEX concentrations and increased microbial populations in the groundwater adjacent to the injection points. The 2nd Street Biosparge System was installed as an interim source control measure to address COIs from this area.

In 2021, in accordance with the *Reformate Release Corrective Action Work Plan,* Phillips 66 conducted hydro-excavation of reformate-contaminated soils and added a slow-release oxygen release compound into the base of the excavation. Hydrogen peroxide was also flushed into the subsurface via a horizontal injection well installed upgradient of the excavation to enhance BTEX degradation. These activities were conducted as a source reduction method to reduce the COI loading on existing downgradient sparge systems.

3.8 Vinyl Chloride Groundwater Plume

Vinyl chloride in groundwater at the Phillips 66 refinery is generally caused by the breakdown of trichloroethene (TCE). Known sources for the vinyl chloride plume, at the southern portion of the refinery, include historical releases from the SOSP, South 40 DNAPL Area, and Area 3 Landfarm.

DNAPL containing CVOCs was detected at the refinery monitoring wells (R-42, R12-PE, and R-40) east of the SOSP. The concentrations trends indicate the mass discharge of TCE has significantly decreased. This decrease was facilitated, in part, by the excavation of all vadose zone soil from the SOSP in 2008.

Vinyl chloride does not degrade easily under anaerobic conditions. The sparge technologies described above create more aerobic conditions in the subsurface that increases degradation of the vinyl chloride plume.

4. Current Site Conditions and Risks

4.1 Active Remedies

The following corrective actions, including interim measures, are being implemented at the refinery:

- NAPL recovery

- Operation of four interim measures sparge systems, including:

    - 2nd Street Biosparge System
    - East Fence Line Biosparge System
    - EFL Ozone-Peroxide Sparge System
    - North Fence Line Sparge System

- Continuation of the site-wide groundwater interceptor system (GWIS) shutdown test

4.2 Groundwater Monitoring

The site-wide groundwater monitoring network is depicted in Figure 3. The groundwater monitoring strategy includes:

- Fluid level gauging
- Compliance point monitoring
- Groundwater plume monitoring
- Corrective action performance monitoring

Wells are gauged and sampled as dictated by the approved CMI Work Plan or IM Work Plan. In the third quarter of 2021, fluid level gauging was completed at 242 wells. Groundwater samples were collected from 140 monitoring locations.

4.3 Groundwater Contamination

Eleven monitoring wells had measurable or observed LNAPL or DNAPL during the third quarter of 2021. Figure 4. LNAPL Thickness shows the observed LNAPL at the refinery. Since 2001, approximately 36,772 gallons of LNAPL have been recovered. This value does not include LNAPL recovered by the GWIS. Approximately 513 gallons of DNAPL have been recovered.

COIs are tracked and evaluated after each sampling event. In general, the COIs at the refinery that drive groundwater monitoring and corrective action are BTEX and vinyl chloride. Figures 5 and 6 show the extent and magnitude of these constituents in 2021. Remedial activities have reduced the extent and magnitude of groundwater contamination. Figures 7 and 8 show changes in BTEX and vinyl chloride concentrations from 2010 to 2021.

Boundary monitoring wells are used to evaluate whether COIs meet the Montana groundwater quality standards in Circular DEQ-7. In the third quarter of 2021, vinyl chloride exceeded groundwater standards in monitoring locations OR-3 and PZ-19. Arsenic was detected in monitoring locations PZ-19 and PZ-23 above groundwater standards.

Arsenic is the primary inorganic COI at the refinery. Arsenic is found at the refinery from refinery contamination, natural occurring amounts in soil, and potentially historical insecticide

use. Arsenic is a natural component of soil in this area. Dissolved arsenic mobilization due to shifting redox conditions resulting from microbial degradation of petroleum hydrocarbons is normal and expected. Widespread use of arsenic-based insecticides (the site's prior use was agricultural) may also be a component of elevated arsenic levels. Arsenic levels have been reduced by corrective action at the site, including sparging technologies. See Figure 9 showing the change in arsenic concentrations over time.

Phillips 66 submitted *OR-3 Chlorinated Volatile Organic Compound Assessment Work Plan* on May 4, 2021. The work plan outlined actions to delineate the CVOC extent in groundwater in preparation for additional corrective action. The focus was on the area upgradient of monitoring well OR-3. DEQ approved the work plan in a letter dated May 4, 2021.

OR-3 Chlorinated Volatile Organic Compound Assessment Report was submitted on December 22, 2021. The investigation concluded that vinyl chloride in the vicinity of well OR-3 is from historical contamination from the vicinity of the Area 3 Landfarm. The bedrock around OR-3 appears to include scours and a paleochannel that presents a pathway for CVOCs in the subsurface. This pathway channels groundwater flow in the OR-3 area, around the southern end of the current EFL O-P system. DEQ required Phillips 66 to submit a work plan to address this extent of the vinyl chloride plume.

On April 29, 2022, Phillips 66 submitted the *Southeast Ozone-Peroxide Sparge System Work Plan.* The work plan addresses vinyl chloride as recommended in the assessment report. DEQ approved the work plan on May 16, 2022.

4.4 Soil Contamination

The surface at the refinery is a mix of concrete, asphalt, gravel-based fill, and soil cover. The cover at the four SWMUs/AOCs included in the proposed remedy are described follows:

- South 40 DNAPL Area - Surface area is covered by clean, gravel-based fill. COIs are limited to subsurface soils, groundwater, and NAPL.

- Butane Release Area - Surface areas are covered by concrete, asphalt, buildings, and clean gravel-based fill. COIs are limited to subsurface soils, groundwater, and NAPL.

- Glacier Manifold Pipeline Release Area - Surface-expressed contaminants were excavated. Surface areas are covered by clean, gravel-based fill. COIs are limited to subsurface soil, groundwater, and NAPL.

- Jupiter Sulphur Expansion - Surface-expressed contaminants were excavated during construction activities. Surface areas are covered by clean, gravel-based fill. COIs are limited to subsurface soils and groundwater.

Leaching of COIs from subsurface soil to groundwater is being monitored. Phillips 66 requires HAZWOPER-trained personnel perform sub-surface work at or within known SWMUs/AOCs and areas where contamination is suspected through an on-site administrative permitting process. This activity is intended to mitigate human health risks.

4.5 Vapor Intrusion

Vapor intrusion is a potential human exposure pathway to hazardous constituents from contact with hazardous vapors. A complete vapor intrusion pathway is required for the exposure in a structure.

In a March 7, 2017 letter, DEQ required Phillips 66 to conduct a vapor intrusion screening. Phillips 66 was directed to follow DEQ's *Montana Vapor Intrusion Guide* for potential impacts from NAPL and dissolved phase groundwater sources. The investigation was conducted in phases. The investigation included two rounds of data collection, including sampling of indoor air, sub-slab vapor, ambient outdoor air, and soil gas at 14 structures within a defined study area. Phillips 66 evaluated the data using a multiple lines of evidence approach. Phillips 66' investigation determined there was no unacceptable vapor intrusion exposures.

DEQ approved Phillips 66' *Phase 3 Vapor Intrusion Evaluation Report* in a letter dated March 5, 2021. DEQ agreed with Phillips 66' recommendation that no further investigation or corrective action related to vapor intrusion is necessary, at this time.

5. Corrective Action Objectives

The corrective action objectives for the site were established in the 2001 CMS Report. The objectives are the following:

1 Prevent leaching of contaminants in soil to groundwater above regulatory or risk-based action levels;

2 Prevent residential use of property in areas that pose unacceptable lifetime human health risk from exposure;

3 Reduce the amount of free product in the aquifer beneath the refinery to the extent possible utilizing available technologies;

4 Prevent unacceptable exposure to human health and the environment from both free product and contaminated groundwater; and

5 Comply with state and federal applicable water quality standards or risk-based concentrations on and off the site.

6. Evaluation of Proposed Remedy

EPA has established guidance for selecting remedies. The guidance provides threshold and balancing criterial for evaluating multiple technologies. When a single remedy alternative is being considered, these criteria serve as a basis to determine that the remedy will be adequate. Phillips 66 proposed one remedy in the CMS Report.

The threshold criteria asks, does the alternative do the following:

- Protect human health and the environment?
- Attain media cleanup objectives?
- Control sources of release?

The proposed remedy meets the criteria because it includes components that protects human health and the environment. The remedy will continue to mitigate human exposure to soil contamination and address groundwater contamination. Source control and boundary control of groundwater containing COI are a focus of corrective action at Phillips 66. The remedy will move towards cleanup objectives including meeting Circular DEQ-7.

If the threshold criteria are met, the balancing criteria are evaluated. Phillips 66' hazardous waste permit follows EPA guidance and requires the corrective measures alternative be evaluated based on the following balancing criteria: long-term reliability and effectiveness; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost. Phillips 66 is required to recommend a corrective measures alternative based on the evaluation of the criteria.

6.1 Long-Term Reliability and Effectiveness

Any potential remedy must be assessed for the long-term reliability and effectiveness it affords, along with the degree of certainty that the remedy will prove successful.

The proposed exposure controls are currently implemented at the refinery, as a part of the 2002 approved remedy. These measures have effectively prevented unacceptable human health and environmental exposures. Since the SWMUs/AOCs included in this remedy selection are located within the refinery boundary or on land owned by Phillips 66, the proposed exposure controls will continue to be reliably implemented.

NAPL source removal will continue under the proposed remedy. Historical groundwater monitoring has documented the reduction of the LNAPL plume. Reductions in LNAPL and DNAPL help reduces the dissolved-phase COIs in groundwater which reduce the load on boundary control measures.

Sparging technologies have been effectively used at Montana sites with hydrocarbon contamination. At Phillips 66, the 2nd Street Biosparge System was implemented in 2015. The functionality of this system has been proven. The proposed source and boundary control sparging measures will require routine operation and maintenance. Phillips 66 has proven their commitment and ability to operate and maintain environmental remedial systems, including LNAPL removal and successful operation of the GWIS. Monitoring and optimization of these systems has occurred since the 2002 remedy approval. The operation and maintenance of the sparging systems is anticipated to have long-term reliability and effectiveness.

6.2 Reduction of Toxicity, Mobility or Volume

A potential remedy must be assessed as to the degree to which it employs treatment that reduces toxicity, mobility or volume of hazardous waste and hazardous constituents. Exposure controls by themselves have no effect on COIs. Reduction of the extent and magnitude of COIs will be addressed by the boundary and source controls.

NAPL removal, a source control, will continue at the refinery. Current recovery methods include absorbent socks, peristaltic pumps, and vacuum trucks. NSZD evaluation is also ongoing. Ongoing well gauging has documented a reduction in NAPL at the refinery. Source reductions are important in reducing dissolved phase COIs. Focused and optimized NAPL removal will continue to be an important remedy to reduce the extent and magnitude of contamination at the refinery.

The COIs evaluated in this section are BTEX and vinyl chloride, because they are the main COIs driving cleanup work at the refinery. The results from the GWIS shutdown test indicate the perimeter sparge systems are effective in controlling the migration of dissolved-phase COIs.

Performance monitoring of the existing sparging technologies has demonstrated a reduction in the toxicity and volume of COIs. The effectiveness of the sparge systems has been evaluated by comparing groundwater monitoring results from upgradient wells with results from wells within each system's radius of influence (ROI) (e.g., comparing the average COI "loading" into the system with the average reduction in COI concentrations due to sparging).

Comparisons have also been made between the analytical results from groundwater samples collected within the ROI and analytical results from groundwater samples collected at monitoring wells at various distances downgradient of the sparge arrays. This is to determine if sparging is affecting downgradient groundwater concentrations. Comparison methods include Mann-Kendall trend analysis, relative changes in concentrations, field parameters, and analyte-specific linear trends (Least Squares Regression).

The sparge systems, with the 2022 additional optimization of the EFL O-P System, appear adequate to provide sufficient oxygen and oxidants to promote biodegradation and oxidation of COIs. System optimization, including adjustments to flow rates and sparging time, is ongoing

to ensure a decrease of COI concentrations in off-site monitoring points. Future monitoring will be used to evaluate the performance of all sparge systems and guide optimization.

Supplemental source mass removal technologies will be designed to reduce the volume of COI sources by bulk removal, enhanced biodegradation, or chemical destruction. For example, at the Reformate Release Area, supplemental source mass technologies may be implemented to reduce concentrations of COIs in groundwater, which will then improve the efficiency of the 2nd Street and NFL biosparging systems.

6.3 Short-term Effectiveness

Short-term effectiveness of a potential remedy shall be assessed considering: the magnitude of reduction of existing risks; risks that might be posed to the community, workers, or the environment during implementation of a remedy; and the time until full protection is achieved. Exposure controls are already in place and mitigate on-site risk.

Boundary controls implemented from 2015 to 2018 show a reduction in BTEX concentrations by 76.1% (EFL O-P) to 99.7% (NFL) when comparing upgradient levels to levels within the treatment zones. During construction of boundary controls, existing exposure controls have and will continue to protect workers.

Sparge systems have been implemented at the refinery since 2015. BTEX concentration reduction have been documented. There are no short-term risks to the community outside of the refinery from exposure to soil or groundwater. There are no down-gradient residential areas that might be impacted by off-site COIs in groundwater. Down-gradient land use include a stock yard, highway, railroad, a city park, and the location of a former power plant.

LNAPL recovery has been occurring at the refinery for approximately 25 years. In general, recovered LNAPL volumes have declined over time and the remaining NAPL masses (both LNAPL and DNAPL) either appear stable or declining.

Supplemental source technologies have the potential to significantly reduce contaminant sources. However, access to contaminant sources at the refinery is often limited because of structures and piping. If technologies beyond NAPL recovery or sparging are implemented, they will generally be evaluated with bench/pilot testing. Phillips 66 will manage any risk through exposure controls and any specific measures identified during design. Risks will be limited to the immediate environment and workers in the project area.

An estimate to achieve full protection, such as onsite compliance with DEQ-7 water quality standards, has not been developed. This site is an active refinery with areas not accessible.

6.4 Implementability

This evaluation considers the ease or difficulty of implementing a remedy.

The proposed exposure controls have been successfully implemented for many years. They are relatively easy to maintain and have become standard operating procedures, increasing their reliability. The sparging systems have been installed and operating at full capacity for several years. During construction the existing exposure controls were used to protect workers.

Phillips 66 has been conducting LNAPL recovery for decades. This source control measure will continue without any difficulty.

The physical and hydrogeological constraints at the refinery will dictate implementation of any supplemental source control technologies. For example, excavation of source soil may be difficult to implement if above or underground piping exist. Technologies that are largely driven by well installation and/or injection points, such as air sparging and soil vapor extraction, will likely be easier to implement. Phillips 66 has successfully demonstrated the ability to install numerous sparging points for source and boundary control.

6.5 Cost

The cost evaluation includes: capital; operation and maintenance; net present value of capital, operations, and maintenance cost; and potential future remedial action costs.

Phillips 66 has provided cost estimates for a 10-year period. The estimated cost is $12,568,000. This cost included estimated capital cost (if known or projected) and annual operation and maintenance cost. Costs are engineering estimates and may range from minus 30% to plus 50%. This range may increase depending upon the number of supplemental technologies used for source control. Phillips 66 has not identified cost as an impediment to remedy implementation.

7. Public Involvement

The public was given the opportunity to comment on the draft permit modification and environmental assessment (EA). No comments were received on the draft EA. DEQ received general comments on the proposed remedy.

DEQ has completed a document responding to commenters. The document is called Response to Comments and is in accordance with 40 Code of Federal Regulations (CFR) 124.17 (incorporated by reference in Administrative Rules of Montana (ARM) 17.53.1201).

DEQ has decided to issue a modification to Phillips 66's hazardous waste permit. The final permit decision is dated September 30, 2022.

An appeal of DEQ's decision must be submitted to the Montana Board of Environmental Review by October 31, 2022 (75-10-406(4), Montana Code Annotated). The final permit decision shall become effective on November 1, 2022, unless appealed.

Module II of the hazardous waste permit (including the Statement of Basis), the Response to Comments, and the final environmental assessment are available on DEQ's website at: https://deq.mt.gov/public/publiccomment and DEQ's main office located at: Montana Department of Environmental Quality**,** 1520 E. 6th Avenue, Helena, Montana (phone 406-444-5300). Office review hours are from 8:00 a.m. to 5:00 p.m. Monday through Friday.

If you need further information, please contact Denise A. Kirkpatrick at the above address, phone (406) 444-3983, or email: dkirkpatrick@mt.gov

Dated: September 30, 2022

Table 1. Corrective Action Status of Solid Waste Management Units (SWMU) and Areas of Concern (AOC)

SWMU/AOC Name	Included in EPA Consent Order	RFI Status	CMS Status	Statement of Basis Date	CMI Status
API Separator	Yes	C	NR	NR	NR
Area 1 Landfill	Yes	C	C	2002	IP
Area 2 Alky Landfill	Yes	C	NR	NR	NR
Area 3 Landfarm	Yes	C	C	2002	C
Area 4 Landfarm	Yes	C	NR	NR	NR
Boiler House Blowdown Pond	Yes	C	C	2002	IP
Butane Release Area	No	C	C	2022	R
COI in Ground Water	No	C	C	2002 & 2022	IP
COI in Soil	No	C	C	2002 & 2022	IP
Former Flare Pit Impoundment	Yes	C	C	2002	IP
Glacier Manifold Pipeline Release	No	C	C	2022	R
Jupiter Sulfur Expansion	No	C	C	2022	R
Northeast Pit Area	Yes	C	C	2002	IP
Northwest Area 3 Landfarm	No	C	NR	NR	NR
Oily Water Process Sewer System	Yes	C	C	2002	IP
Process Area Diversion Pond	Yes	C	C	2002	IP
Product on Ground Water	No	C	C	2002 & 2022	IP
South 40 DNAPL	No	C	C	2022	R
South Oily Sludge Pits	Yes	C	C	2006	C
Tank 80	No	NR	NR	NR	NR
Tank Farm Area	No	C	C	2002	IP
Trenches Area of Concern	No	C	C	2002	IP
Truck and Tank Car Loading Area	Yes	C	C	2002	IP

C Complete
R Required
RFI RCRA Facility Investigation
CMI Corrective Measures Implementation
NR Not Required
IP In Progress
CMS Corrective Measures Study

Table 2. 2022 Proposed Remedy - Phillips 66 Company Billings Refinery

SWMU/AOC	Description	Current Status	2020 CMS Evaluation	2022 Corrective Measures
2020 Study Area				
South 40 DNAPL	DNAPL discovered in process of investigating SWMUs in southern portion of the Refinery.	IMs - Ongoing. Located within site-wide groundwater monitoring program. Pilot testing of in-situ chemical oxidation technologies concluded in December 2021.	CVOC concentration trends indicate the primary source of the VC plume is TCE in the vicinity of the Area 3 Landfarm, SOSP, and South 40 DNAPL Area. Excavation of SOSP soils has decreased CVOC source mass and decreased concentrations in the VC plume.	Sparge systems will be operated to mitigate off-site migration of COIs in groundwater. Product removal will be conducted in wells with measurable NAPL to the extent practical. Monitoring will be conducted to evaluate permit compliance, corrective action performance, monitored natural attenuation (MNA), and plume characteristics. Source reduction technologies may be employed to the extent practical.
Butane Release Area	Leak in Glacier Butane Delivery Pipeline. Butane release to soil.	IMs - Ongoing. Located within site-wide groundwater monitoring program	Performance monitoring for the East Fence Line Biosparge System indicates COIs are controlled downgradient of the AOC.	
Glacier Manifold Pipeline Release	Area beneath the Glacier Pipeline crude oil manifold. Soil impacts from release.	IMs – Ongoing product recovery. Located within the site-wide monitoring program.	No change	
Jupiter Sulphur Expansion	Contaminated soils northeast of the Area 3 Landfarm discovered during construction of the Jupiter Sulphur plant expansion in 2015.	Located within site-wide groundwater monitoring program.	Analytical results presented in 2017 RFI indicate the SWMU is not a significant source of COIs leaching to groundwater from soils.	
Reformate Release Area (Within existing AOCs: Tank Farm Area, COI in Groundwater, and COI in Soil)	Release from buried reformate transfer line near Tank 21 discovered in 2012.	IMs - Ongoing. 2nd Street Biosparge installed as a plume control measure. Remedial assessment is ongoing. Located within site-wide groundwater monitoring program.	Data from routine groundwater monitoring events indicate the Reformate Release Area is a source of BTEX constituents in soil and groundwater.	
COI in Groundwater – (Includes the Vinyl Chloride Plume)	Dissolved-phase VC in the southern portion of the Refinery.	Dissolved-phase VC at the refinery is attributed to historical operations, specifically SWMUs and AOCs near the southern portion of the refinery	CVOC concentration trends indicate the primary source of the VC plume is TCE in the vicinity of the Area 3 Landfarm, SOSP, and South 40 DNAPL Area.	

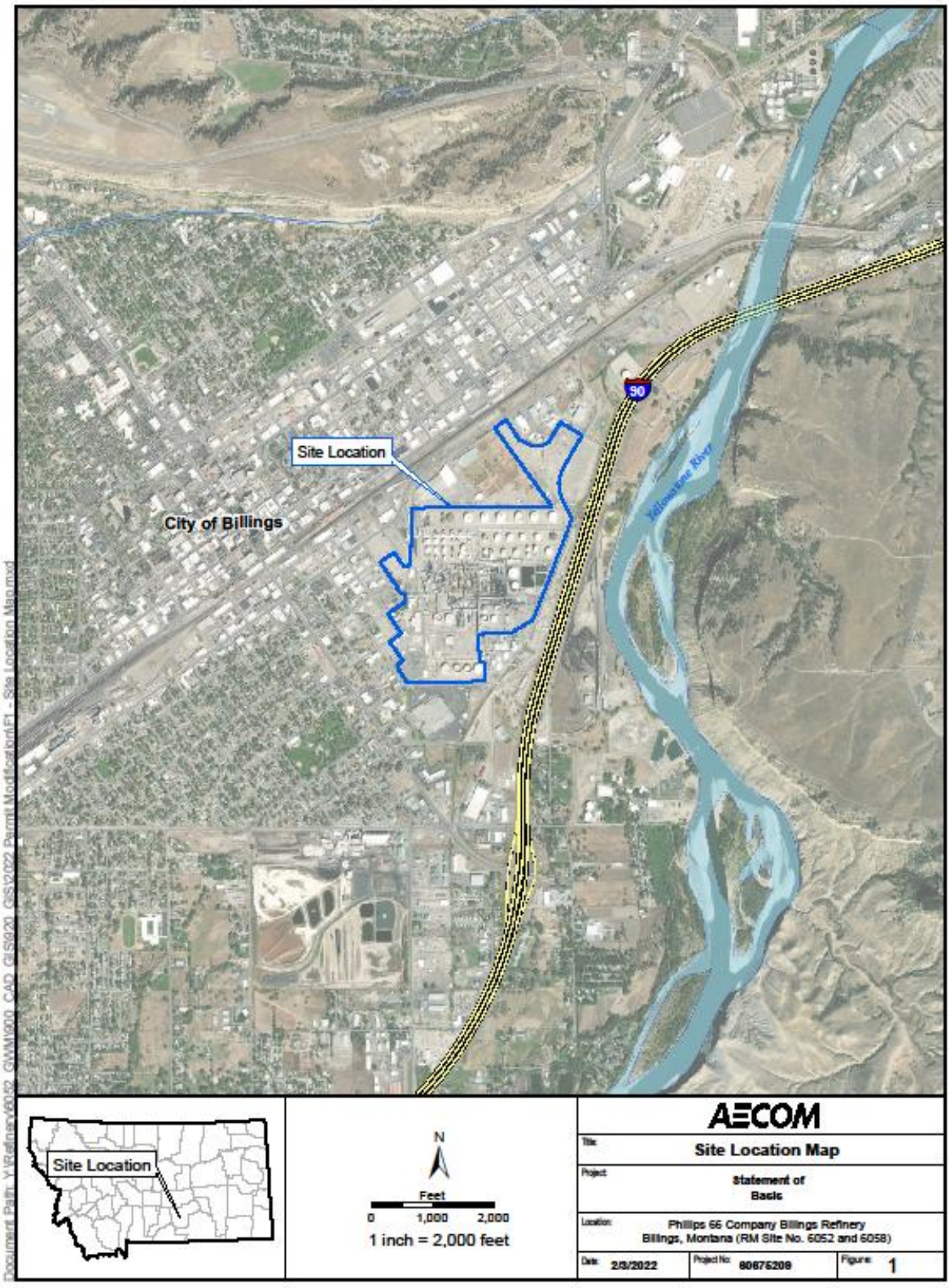
SWMU/AOC	Description	Current Status	2020 CMS Evaluation	2022 Corrective Measures
South 40 Area				
Area 3 Landfarm	Operated from 1970 - 1972 as a landfarm for petroleum refining waste. Soil includes contamination with CVOCs.	No further action (NFA) determination for soils. SWMU downgraded to low-priority. Located within the site-wide groundwater monitoring program.	CVOC concentration trends indicate the primary source of the VC plume is TCE in thevicinity of the Area 3 Landfarm, SOSP, and South 40 DNAPL Area. Excavation of SOSP soils has decreased CVOC source mass and decreased concentrations in the VC plume.	Sparge systems will be operated to prevent off-site migration of groundwater and COIs. Product removal will be conducted in wells with measurable LNAPL, if needed, to the extent practical. Monitoring will be conducted to evaluate MNA and plume characteristics. Corrective measures taken to address the VC plume may also affect this unit.
Area 4 Landfill	Used for disposal of discarded valves, piping, broken concrete, and spent FCC catalyst. Soil contamination includes VOCs, SVOCs, and metals.	NFA for soils. Located within the site-widegroundwater monitoring program.	No change	Sparge systems will be operated to prevent off-site migration of COIs contaminated groundwater. Monitoring will be conducted to evaluate MNA and plume characteristics.
South Oily Sludge Pits (SOSP)	Former temporary storage area for API separator sludge and other refinery waste. Vadose zone soils were excavated and disposed.	NFA for soils (vadose zone soils excavated). Located within the site-widegroundwater monitoring program.	CVOC concentration trends indicate the primary source of the VC plume is TCE in the vicinity of the Area 3 Landfarm, SOSP, and South 40 DNAPL Area. Excavation of SOSP soils has decreased CVOC source mass and decreased concentrations in the VC plume.	
Northwest Area 3 Landfarm	Former FCC catalyst and landfarm material in soils.	NFA for soils. Located within the site-widegroundwater monitoring program.	No change	

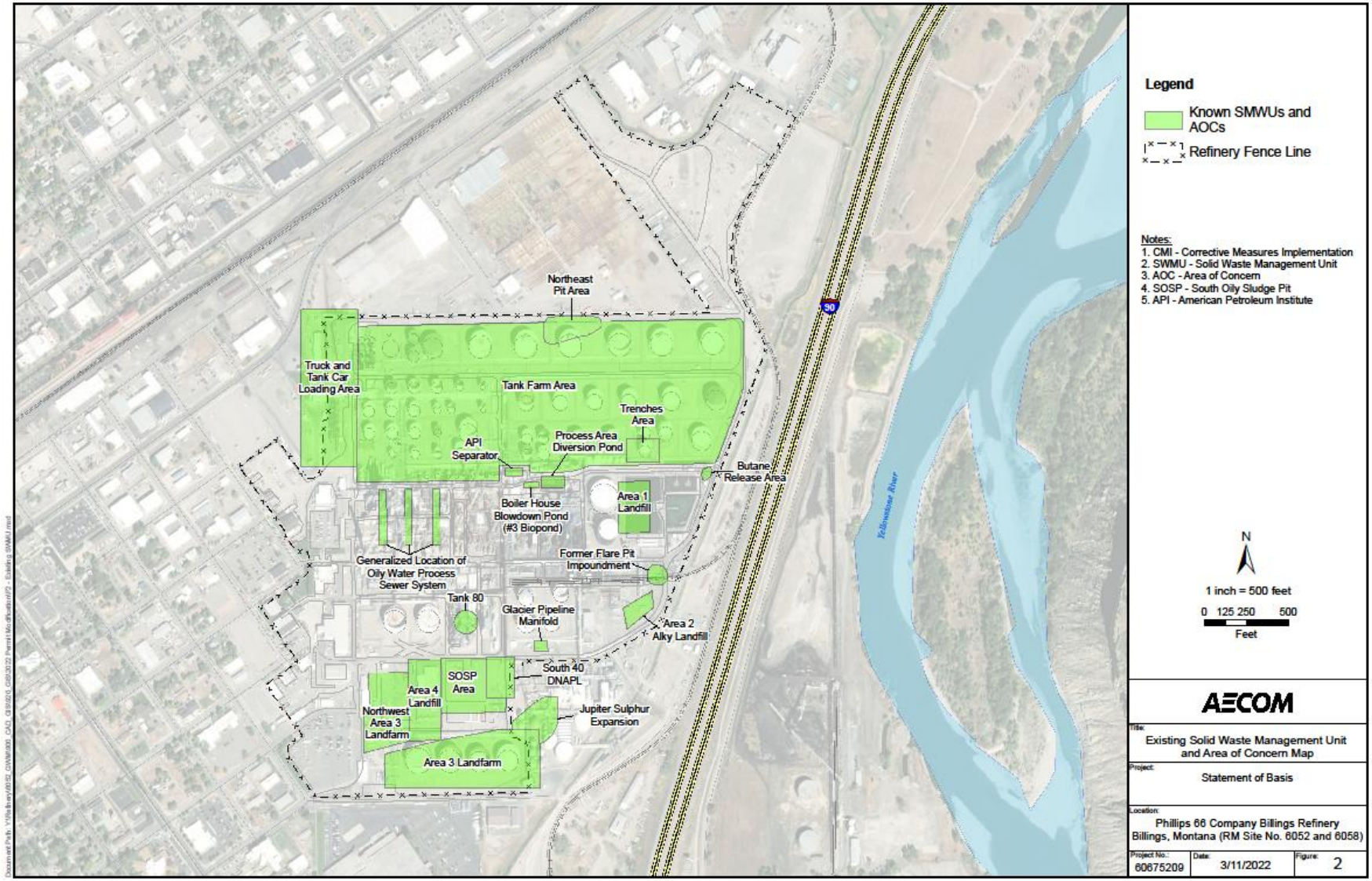
SWMU/AOC	Description	Current Status	2020 CMS Evaluation	2022 Corrective Measures
Wastewater Treatment Units/Flare Units				
Former API Separator	Wastewater treatment unit. Upgradient sources of COI and LNAPL may have affected groundwater beneath the API.	NFA, CMI Not Required - Located within the site-wide groundwater monitoring program.	No change	Sparge systems will be operated to prevent off-site migration of groundwater and COIs. Monitoring will be conducted to evaluate MNA and plume characteristics.
Area 1 Landfill	The SWMU is capped by the asphalt floor beneath the Emergency Holding Pond. While the refinery continues to operate, contaminated soils are not accessible.	CMI - Ongoing. Located within the site-widegroundwater monitoring program.		
Area 2 Alky Landfill	Used for disposal of equipment associated with alkylation unit. Soil with VOCs, SVOCs, and metals; groundwater inconclusive due to upgradient sources of COIs and LNAPL.	CMI - Ongoing. Located within the site-widegroundwater monitoring program.		
Boiler House Blowdown Pond/No. 3 Bio-Pond	Demineralizer regeneration of wastes and steam generation of blowdown waters handled in this unit. No longer in service; filled with soil. Possible impact to groundwater via leachable soils.	NFA. Located within the site-widegroundwater monitoring program.		
Former Flare Pit Impoundment	Located on 1957 aerial photograph; no records of wastes managed on this area. Potential soil with leachable VOCs.	CMI - Ongoing. Located within the site-widegroundwater monitoring program.		
Process Area Diversion Pond	Partially in-ground concrete basin with two bays; pond has contained overflow from the oil process wastewater that exceeded capacity of API separator.	NFA for soils. Located within the site-widegroundwater monitoring program.		

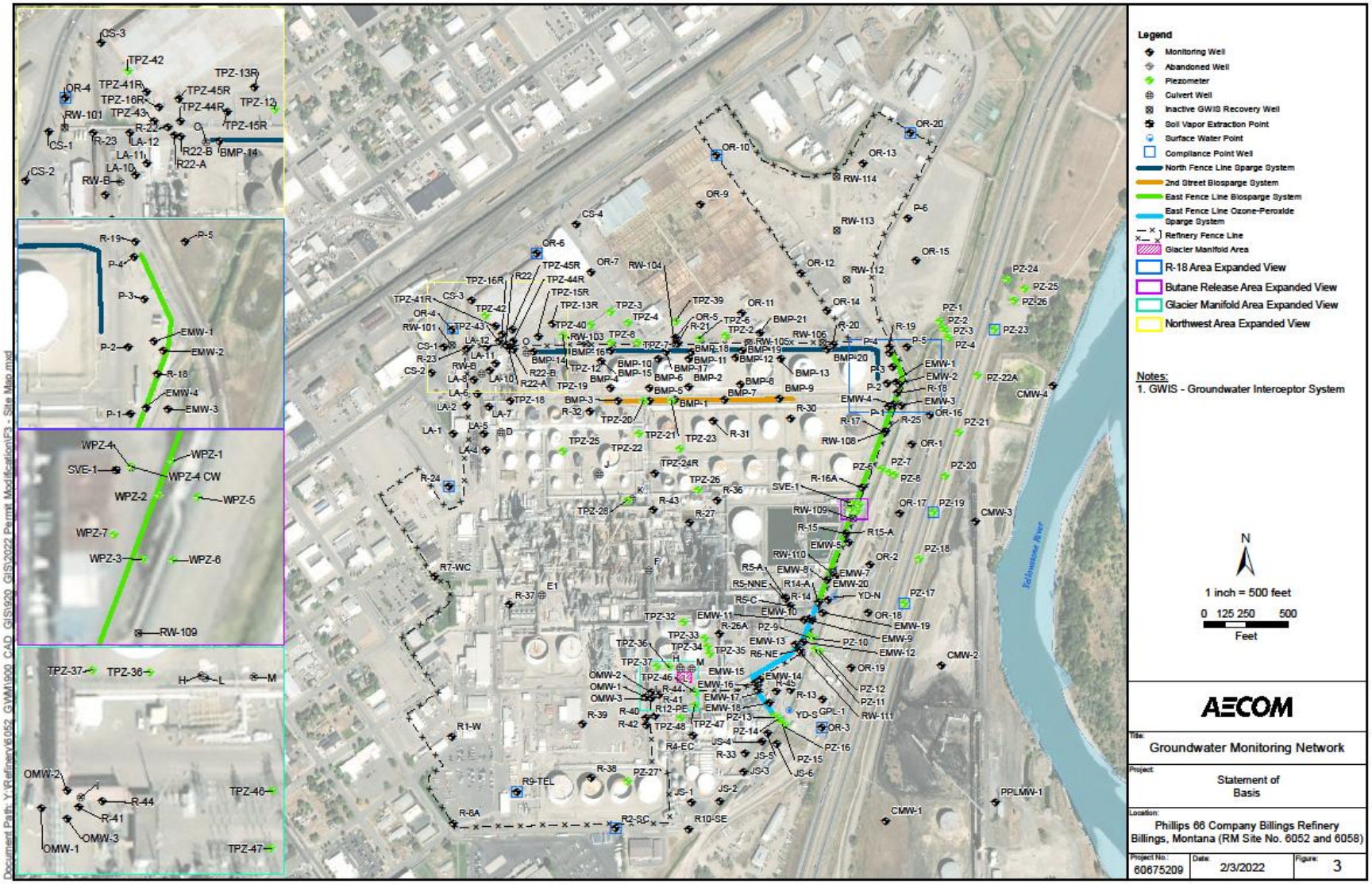
SWMU/AOC	Description	Current Status	2020 CMS Evaluation	2022 Corrective Measures
Processing/Tank Farm				
Northeast Pit Area	Identified in 1950 aerial photograph: no records for waste managed on this area. Soil with leachable organic COI.	CMI - Ongoing. Located within the site-widegroundwater monitoring program	No change	Sparge systems will be operated to prevent off-site migration of groundwater and COIs. Monitoring will be conducted to evaluate MNA.
Oily Water Process Sewer System	Refinery-wide oily water process sewer system.	CMI - Ongoing. Inspection/repair/replacement as accessed. Located within the site-wide groundwater monitoring program.	No change	Continue ongoing repair/replacement as accessed.
Tank Farm Area	Tank farm area on refinery. Soil with leachable organic COI.	CMI - Ongoing. Located within site-widegroundwater monitoring program.	Reformate Release Area included in 2020 Study Area located above. AOC boundary corrected.	Sparge systems will be operated to prevent off-site migration of COIs. Monitoring will be conducted to evaluate MNA and plume characteristics.
Tank 80	Soil with leachable inorganic COI.	RFI - Not Required; CMS - Not Required; CMI - Not Required	No change	
Trenches Area of Concern	Two trenches containing dark liquid; no records for waste managed on this area. Soil with leachable organic COI.	CMI - Ongoing. Located within site-widegroundwater monitoring program.	No change	
Truck and Tank Car Loading Area	Loading area used for management and distributionof petroleum products. Diesel release to soil.	NFA for soils. Area is located within site-wide groundwater monitoring program.	No change	Product removal will be conducted in wells with measurable NAPL to the extent practical.
Refinery Wide				
COI in Groundwater	Site-wide groundwater contaminated with COI.	CMI – Ongoing	Vinyl chloride and Reformate Release Area included in 2020 study area above.	Sparge systems will be operated to prevent off-site migration of groundwater and COIs. Product removal will be conducted in wells with measurable NAPL to the extent practical. Monitoring will be conducted to evaluate permit compliance, corrective action performance, MNA, and plume characteristics.
COI in Soil	Site-wide soils including AOCs and SWMUs.	CMI – Ongoing	Reformate Release Area included in 2020 study area above.	
Product on Groundwater	LNAPL on groundwater	CMI – Ongoing	No change	

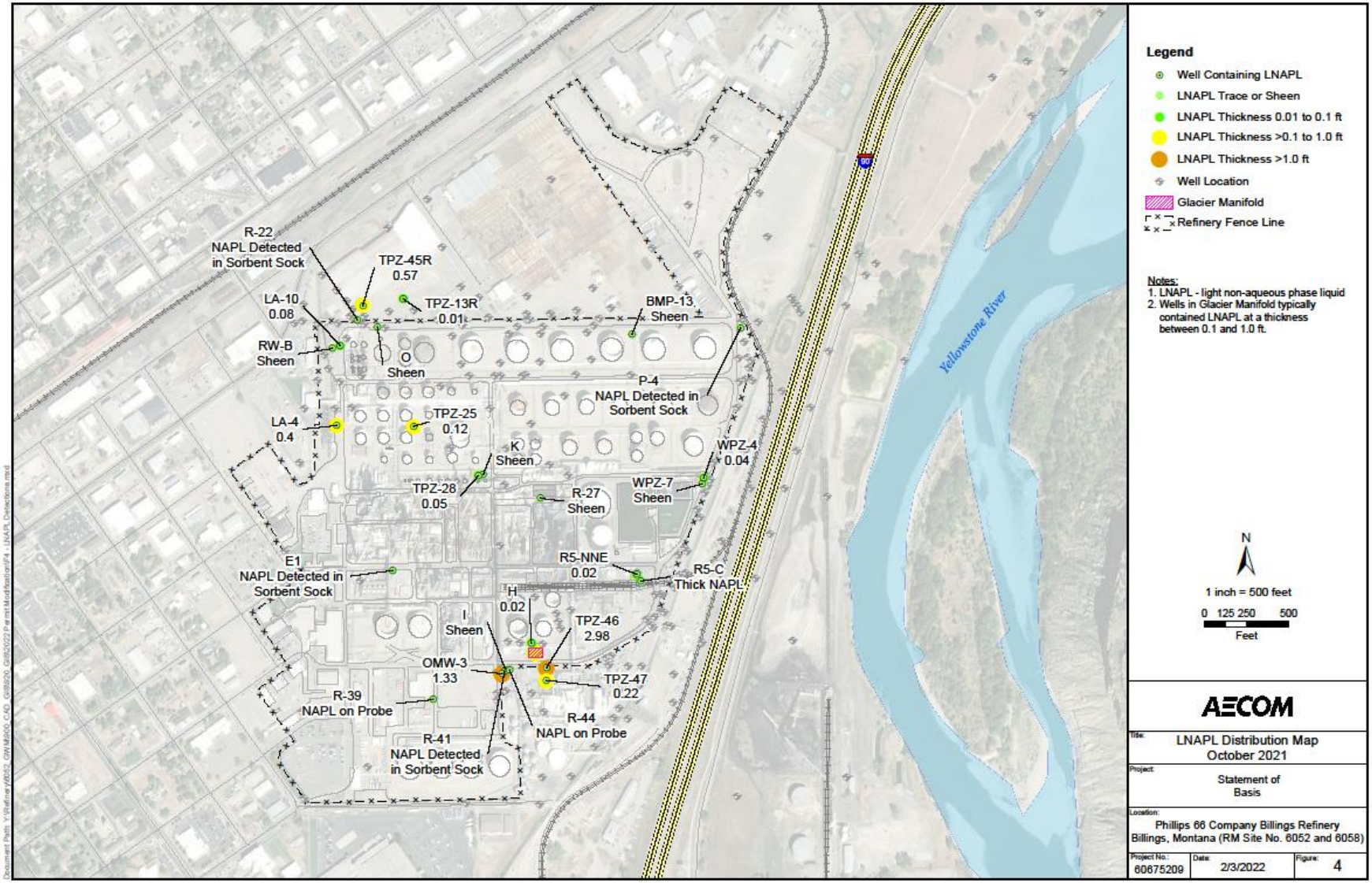
Table Acronyms

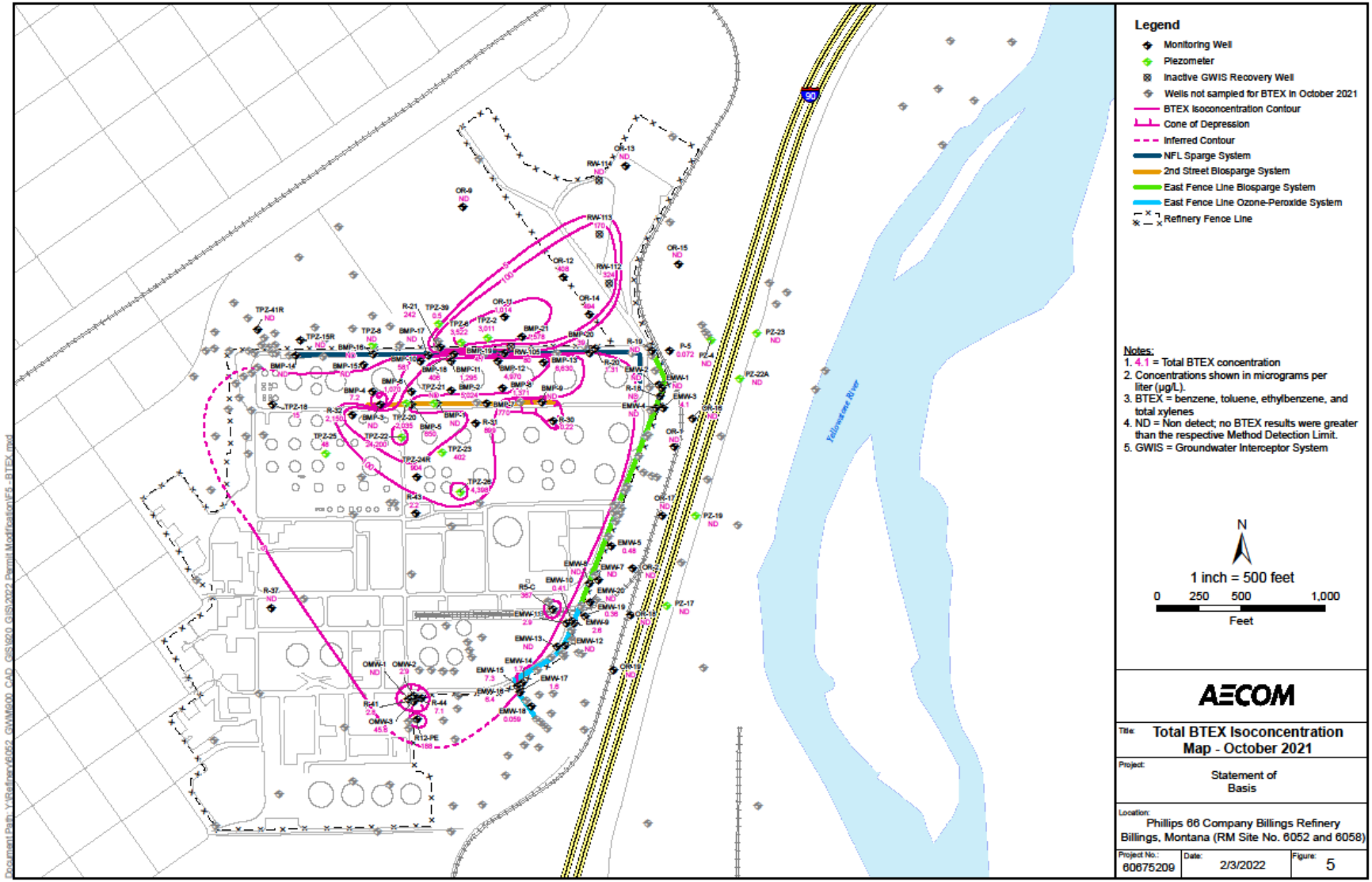
AOC = Area of Concern
BTEX = benzene, toluene, ethylbenzene, xylenes
CMA = Corrective Measures Alternative
CMI = Corrective Measures Implementation
COI = constituent of interest
CVOC = chlorinated volatile organic compound
DNAPL = dense non-aqueous phase liquid
IM = Interim Measures
LNAPL = light non-aqueous phase liquid
MNA = monitored natural attenuation
NAPL = non-aqueous phase liquid
NFA = No Further Action
SMWU = Solid Waste Management Unit
SVOC = semi-volatile organic compound
TCE = trichloroethylene
VC = vinyl chloride
VOC = volatile organic compound

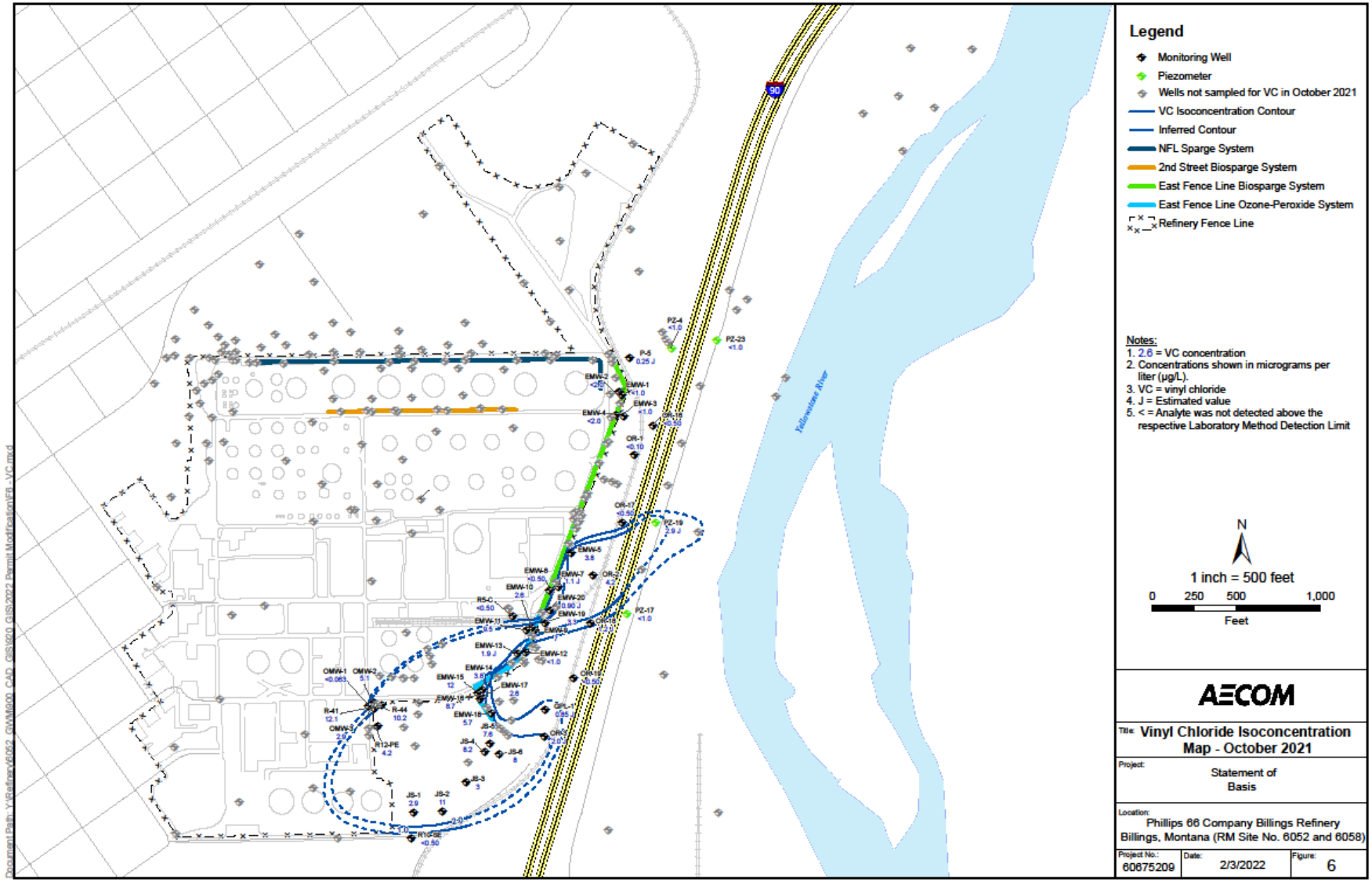

Site Location
City of Billings
90
Yellowstone River
Site Location
N
Feet
0
1,000
2,000
1 inch = 2,000 feet
AECOM
Site Location Map
Statement of Basis
Phillips 66 Company Billings Refinery
Billings, Montana (RM Site No. 6052 and 6058)
2/3/2022
60675209
1

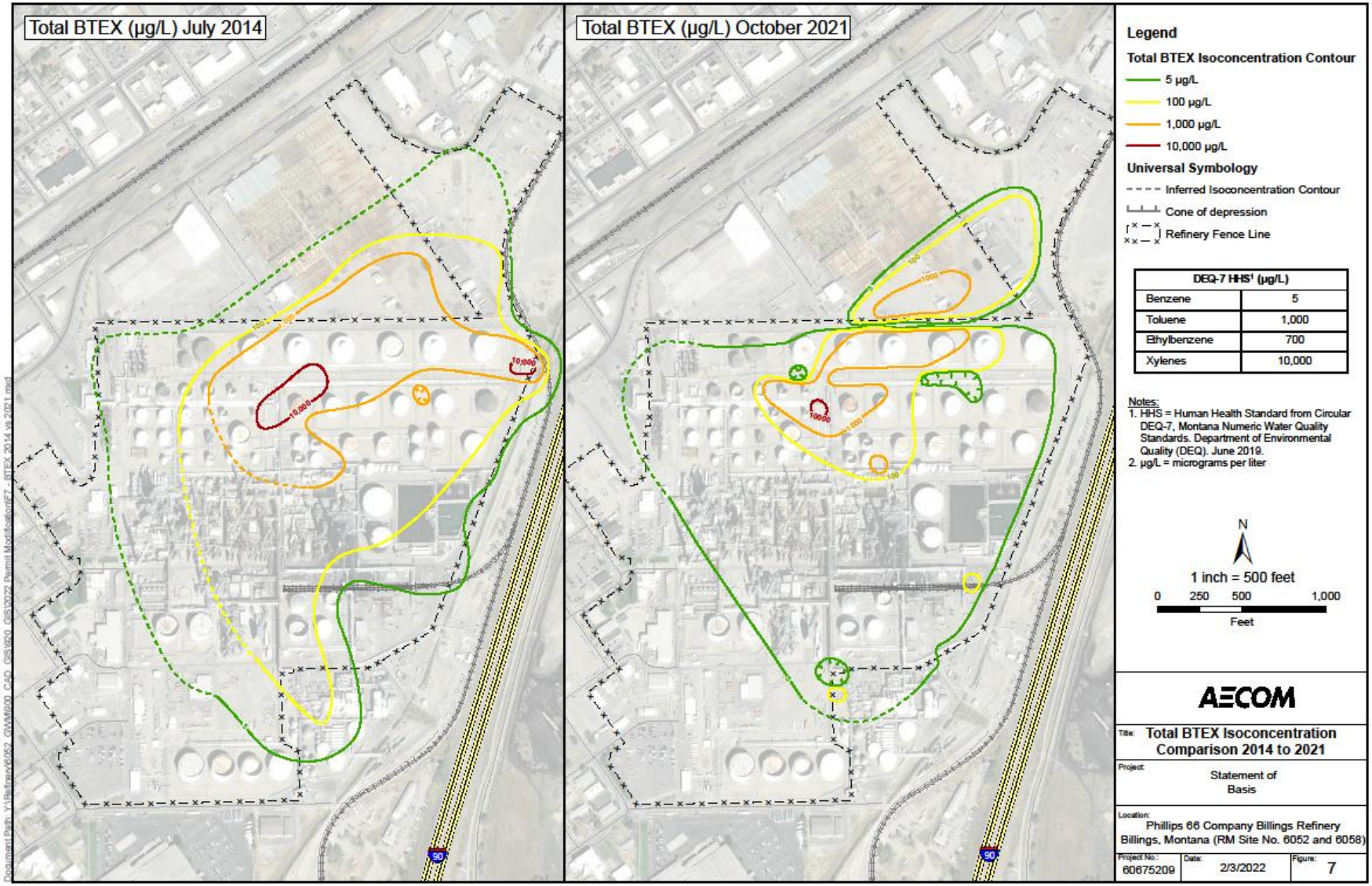

Northeast Pit Area
Truck and Tank Car Loading Area
Tank Farm Area
Trenches Area
Process Area Diversion Pond
API Separator
Butane Release Area
Boiler House Blowdown Pond (#3 Biopond)
Area 1 Landfill
Generalized Location of Oily Water Process Sewer System
Former Flare Pit Impoundment
Tank 80
Glacier Pipeline Manifold
Area 2 Alky Landfill
South 40 DNAPL
SOSP Area
Area 4 Landfill
Northwest Area 3 Landfarm
Jupiter Sulphur Expansion
Area 3 Landfarm
90
Yellowstone River
Legend
Known SMWUs and AOCs
Refinery Fence Line
Notes:
1. CMI - Corrective Measures Implementation
2. SWMU - Solid Waste Management Unit
3. AOC - Area of Concern
4. SOSP - South Oily Sludge Pit
5. API - American Petroleum Institute
N
1 inch = 500 feet
0 125 250 500
Feet
AECOM
Title: Existing Solid Waste Management Unit and Area of Concern Map
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 3/11/2022
Figure: 2


Legend
Monitoring Well
Abandoned Well
Piezometer
Culvert Well
Inactive GWIS Recovery Well
Soil Vapor Extraction Point
Surface Water Point
Compliance Point Well
North Fence Line Sparge System
2nd Street Biosparge System
East Fence Line Biosparge System
East Fence Line Ozone-Peroxide Sparge System
Refinery Fence Line
Glacier Manifold Area
R-18 Area Expanded View
Butane Release Area Expanded View
Glacier Manifold Area Expanded View
Northwest Area Expanded View
Notes:
1. GWIS - Groundwater Interceptor System
N
1 inch = 500 feet
0 125 250 500
Feet
AECOM
Title: Groundwater Monitoring Network
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/3/2022
Figure: 3
Document Path: Y:\Refinery\6052_GWM\900_CAD_GIS\920_GIS\2022 Permit Modification\F3 - Site Map.mxd
Yellowstone River

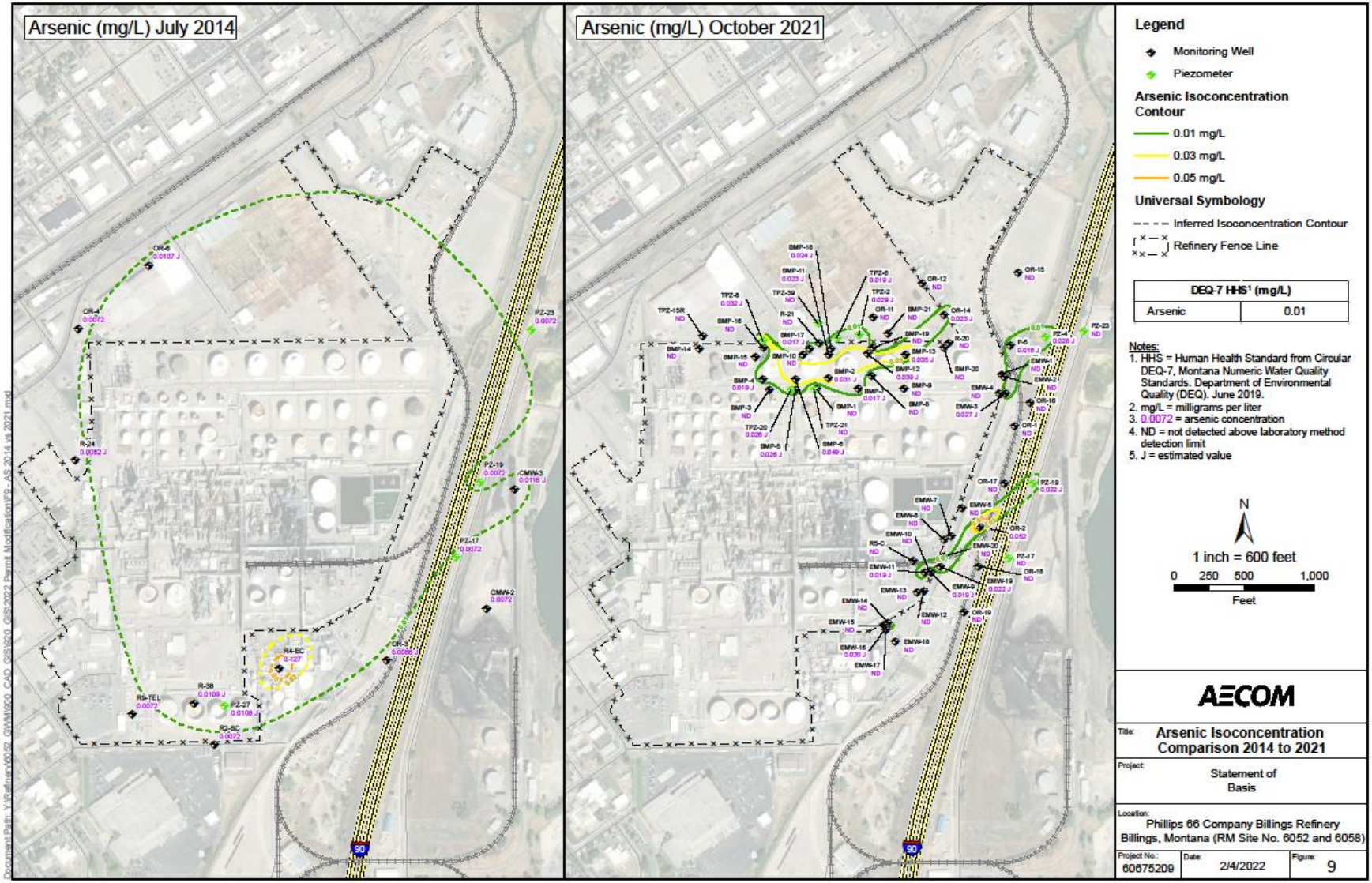

R-22
NAPL Detected in Sorbent Sock
TPZ-45R
0.57
LA-10
0.08
TPZ-13R
0.01
BMP-13
Sheen
RW-B
Sheen
O
Sheen
P-4
NAPL Detected in Sorbent Sock
LA-4
0.4
TPZ-25
0.12
K
Sheen
WPZ-4
0.04
TPZ-28
0.05
R-27
Sheen
WPZ-7
Sheen
E1
NAPL Detected in Sorbent Sock
R5-NNE
0.02
R5-C
Thick NAPL
H
0.02
I
Sheen
TPZ-46
2.98
OMW-3
1.33
TPZ-47
0.22
R-39
NAPL on Probe
R-44
NAPL on Probe
R-41
NAPL Detected in Sorbent Sock
Yellowstone River
90
Legend
Well Containing LNAPL
LNAPL Trace or Sheen
LNAPL Thickness 0.01 to 0.1 ft
LNAPL Thickness >0.1 to 1.0 ft
LNAPL Thickness >1.0 ft
Well Location
Glacier Manifold
Refinery Fence Line
Notes:
1. LNAPL - light non-aqueous phase liquid
2. Wells in Glacier Manifold typically contained LNAPL at a thickness between 0.1 and 1.0 ft.
N
1 inch = 500 feet
0 125 250 500
Feet
AECOM
Title: LNAPL Distribution Map October 2021
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/3/2022
Figure: 4


Legend
Monitoring Well
Piezometer
Inactive GWIS Recovery Well
Wells not sampled for BTEX in October 2021
BTEX Isoconcentration Contour
Cone of Depression
Inferred Contour
NFL Sparge System
2nd Street Biosparge System
East Fence Line Biosparge System
East Fence Line Ozone-Peroxide System
Refinery Fence Line
Notes:
1. 4.1 = Total BTEX concentration
2. Concentrations shown in micrograms per liter (µg/L).
3. BTEX = benzene, toluene, ethylbenzene, and total xylenes
4. ND = Non detect; no BTEX results were greater than the respective Method Detection Limit.
5. GWIS = Groundwater Interceptor System
N
1 inch = 500 feet
0 250 500 1,000
Feet
AECOM
Title: Total BTEX Isoconcentration Map - October 2021
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/3/2022
Figure: 5
Yellowstone River
90


Legend
Monitoring Well
Piezometer
Wells not sampled for VC in October 2021
VC Isoconcentration Contour
Inferred Contour
NFL Sparge System
2nd Street Biosparge System
East Fence Line Biosparge System
East Fence Line Ozone-Peroxide System
Refinery Fence Line
Notes:
1. 2.6 = VC concentration
2. Concentrations shown in micrograms per liter (µg/L).
3. VC = vinyl chloride
4. J = Estimated value
5. < = Analyte was not detected above the respective Laboratory Method Detection Limit
N
1 inch = 500 feet
0 250 500 1,000
Feet
AECOM
Title: Vinyl Chloride Isoconcentration Map - October 2021
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/3/2022
Figure: 6
Yellowstone River
90


Total BTEX (µg/L) July 2014
Total BTEX (µg/L) October 2021
Legend
Total BTEX Isoconcentration Contour
5 µg/L
100 µg/L
1,000 µg/L
10,000 µg/L
Universal Symbology
Inferred Isoconcentration Contour
Cone of depression
Refinery Fence Line
DEQ-7 HHS[1] (µg/L)
Benzene 5
Toluene 1,000
Ethylbenzene 700
Xylenes 10,000
Notes:
1. HHS = Human Health Standard from Circular DEQ-7, Montana Numeric Water Quality Standards. Department of Environmental Quality (DEQ). June 2019.
2. µg/L = micrograms per liter
N
1 inch = 500 feet
0 250 500 1,000
Feet
AECOM
Title: Total BTEX Isoconcentration Comparison 2014 to 2021
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/3/2022
Figure: 7


Vinyl Chloride (µg/L) July 2010
Vinyl Chloride (µg/L) October 2021
Legend
Vinyl Chloride
Isoconcentration Contour
0.2 µg/L
1.0 µg/L
2.0 µg/L
10 µg/L
Universal Symbology
Inferred Isoconcentration Contour
Refinery Fence Line
DEQ-7 HHS[1] (µg/L)
Vinyl Chloride
0.2
Notes:
1. HHS = Human Health Standard from Circular DEQ-7, Montana Numeric Water Quality Standards. Department of Environmental Quality (DEQ). June 2019.
2. µg/L = micrograms per liter
N
1 inch = 500 feet
0 250 500 1,000
Feet
AECOM
Title: Vinyl Chloride Isoconcentration Comparison 2010 to 2021
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/3/2022
Figure: 8


Arsenic (mg/L) July 2014
Arsenic (mg/L) October 2021
Legend
Monitoring Well
Piezometer
Arsenic Isoconcentration Contour
0.01 mg/L
0.03 mg/L
0.05 mg/L
Universal Symbology
Inferred Isoconcentration Contour
Refinery Fence Line
DEQ-7 HHS[1] (mg/L)
Arsenic 0.01
Notes:
1. HHS = Human Health Standard from Circular DEQ-7, Montana Numeric Water Quality Standards. Department of Environmental Quality (DEQ). June 2019.
2. mg/L = milligrams per liter
3. 0.0072 = arsenic concentration
4. ND = not detected above laboratory method detection limit
5. J = estimated value
N
1 inch = 600 feet
0 250 500 1,000
Feet
AECOM
Title: Arsenic Isoconcentration Comparison 2014 to 2021
Project: Statement of Basis
Location: Phillips 66 Company Billings Refinery Billings, Montana (RM Site No. 6052 and 6058)
Project No.: 60675209
Date: 2/4/2022
Figure: 9